



**BIOrescue:**  
A novel biorefinery concept for mushroom compost

[www.biorescue.eu](http://www.biorescue.eu)

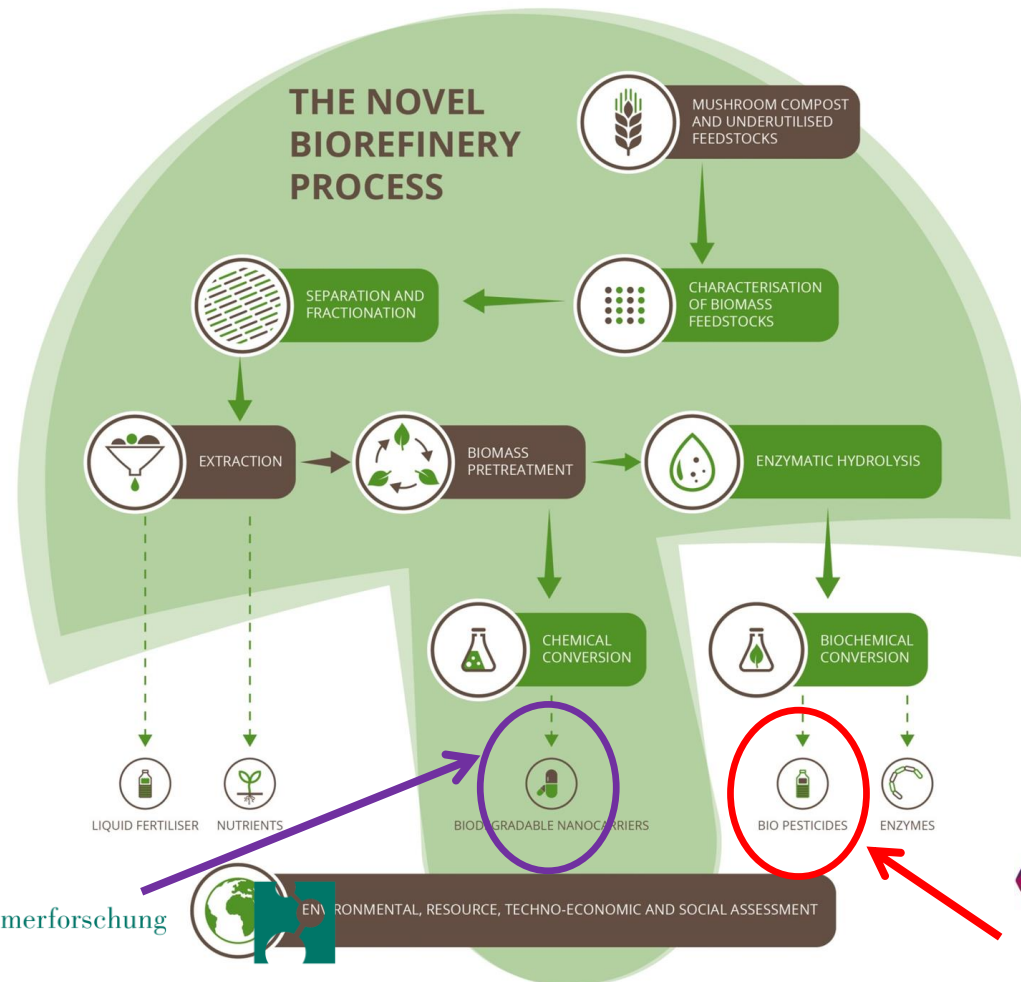
# SUSTAINABLE AND LOW COST BIOPESTICIDES

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Max-Planck-Institut für Polymerforschung  
Max Planck Institute for Polymer Research





## SUSTAINABLE AND LOW COST BIOPESTICIDES

- ✓ Biopesticide:
  - ✓ compounds that are used to manage agricultural pests
  - ✓ natural organisms or substances derived from natural materials (such as animals, plants, bacteria, or certain minerals), including their genes or metabolites, for controlling pests → wide spectrum
- ✓ Biopesticide classification (US Environmental Protection Agency (EPA))
  - Microbial pesticides and other entomopathogens: pesticides that contain microorganisms (bacteria, fungi, virus, etc), which attack specific pest species.
  - Plant-Incorporated Protectants (PIPs): these include pesticidal substances that are produced in genetically modified plants/organisms (GMO)
  - Biochemical pesticides: pesticides based on naturally occurring substances that control pests by non-toxic mechanisms (pheromones, plant extracts, insect growth regulators)



## SUSTAINABLE AND LOW COST BIOPESTICIDES

### Bacterial Biopesticide:

- ✓ most common form of microbial pesticides
- ✓ Can function as insecticides, although they can be used to control the growth of plant pathogenic bacteria and fungi.
- ✓ Generally specific to individual species of moths and butterflies or species of beetles, flies, and mosquitoes.
- ✓ To be effective, they must come into contact with the target pest and may be required to be ingested. In insects, bacteria disrupt the digestive system by producing endotoxins that are often specific to the particular insect pest.
- ✓ The most widely used microbial pesticides are subspecies and strains of *B. thuringiensis* (Bt), accounting for approximately 90 % of the biopesticide market in the USA (Chattopadhyay et al. 2004 ).
- ✓ To date, over one hundred *B. thuringiensis* - based bioinsecticides, biopesticides, and biofungicides have been developed (Mishra et al.; 2015)



## SUSTAINABLE AND LOW COST BIOPESTICIDES

### BIOPESTICIDES FROM MUSHROOM COMPOST

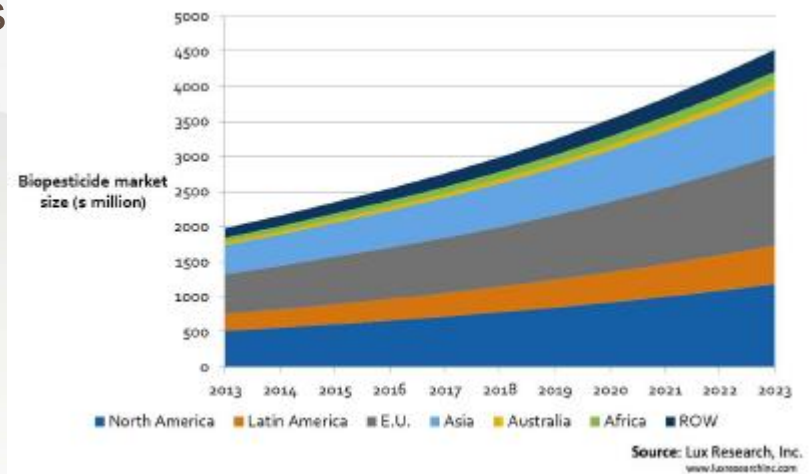
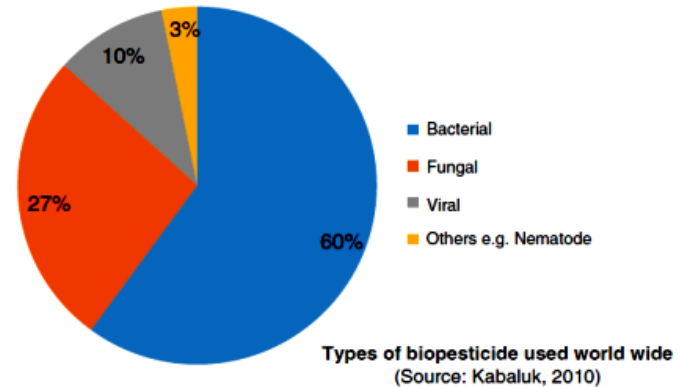
PESTICIDES	BIOPESTICIDES
X Generates an extensive pollution of the environment	✓ Environment and human health friendly
X Creates serious health hazard due to the presence of their residues in food	✓ More sustainable than the application of chemicals
X Produces development of resistance in targeted insect pest populations	✓ Very high specificity to target pests
X Decrease in biodiversity	✓ Do not leave harmful residues
X Outbreaks of secondary pests that are normally controlled by natural enemies	✓ Reduced shelf lives



# SUSTAINABLE AND LOW COST BIOPESTICIDES

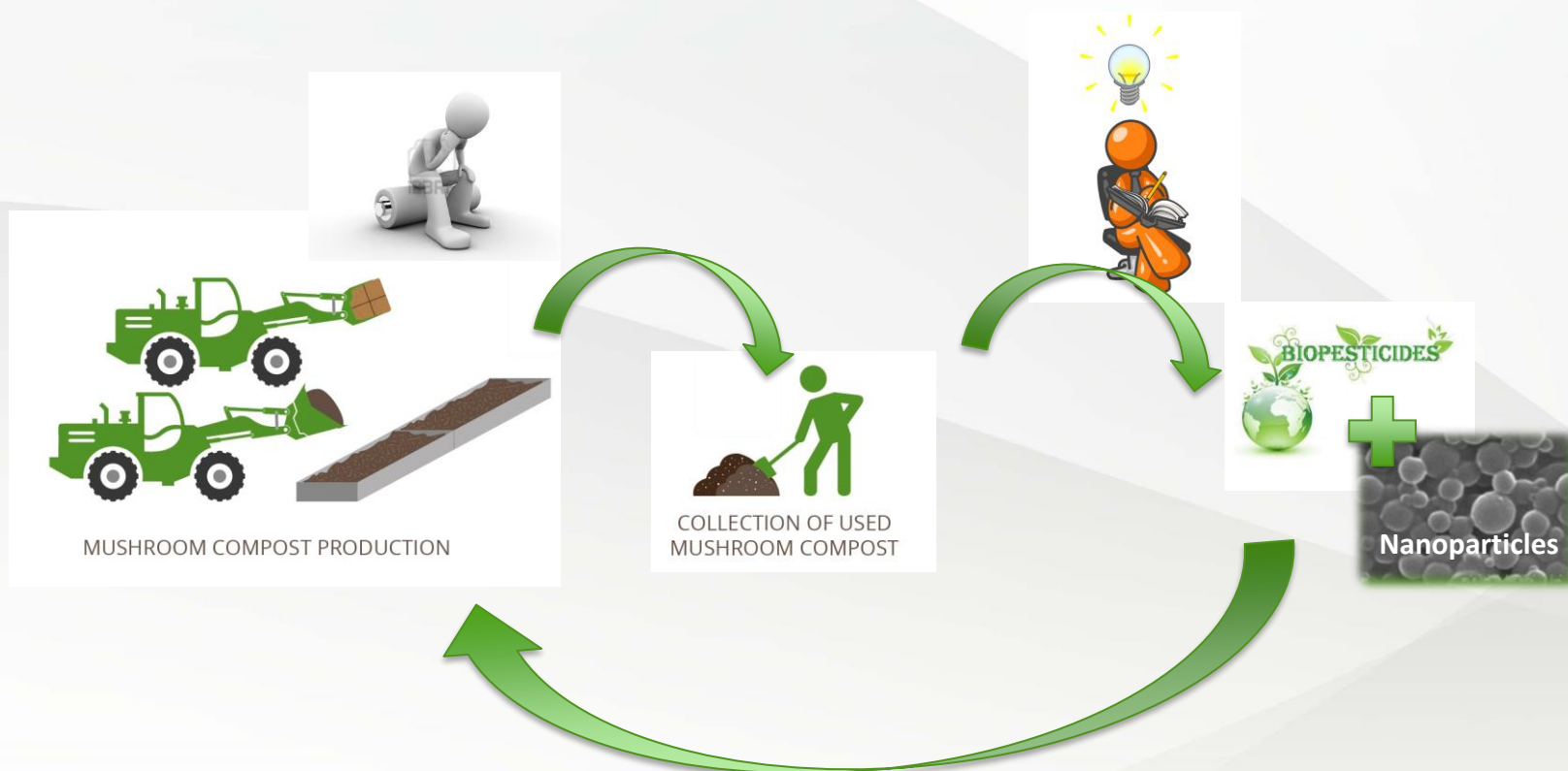
## Biopesticides & future market:

- biopesticide use at a global scale is increasing by almost 10% every year (Kumar, S. et al., 2015)
- global market must increase further in the future if biopesticides are to play a visible role in substituting for chemical pesticides
- chemical product regulations have become tighter
  - complexity of EU-based biopesticide regulations (Balog, A. et al., 2017)
  - Economic viability





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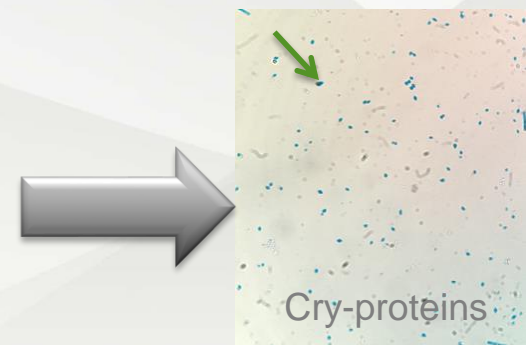
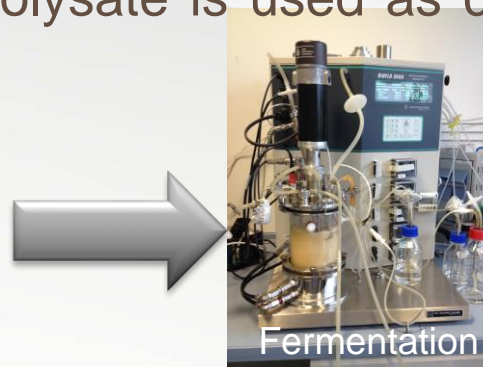
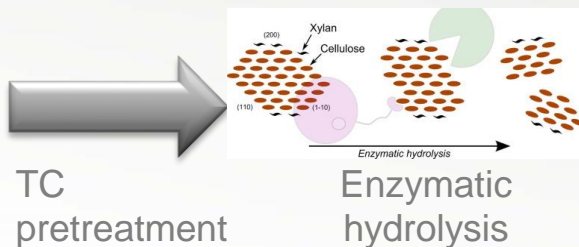




## SUSTAINABLE AND LOW COST BIOPESTICIDES BIOPESTICIDES FROM MUSHROOM COMPOST

- ✓ Biopesticide production:
  - ✓ Biopesticide is produced by *Bacillus thuringiensis* HD1 → lepidoptera pest
  - ✓ Bt produces proteins (Crys) which are characterised by:

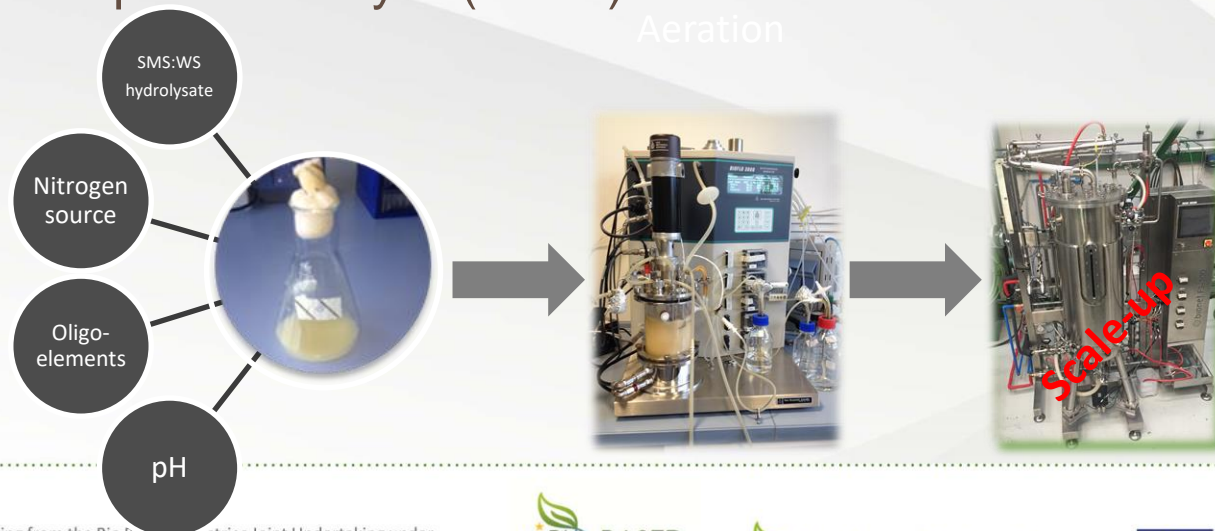
+ <b>High specificity</b>	- <b>Labile</b>
+ <b>Biodegradable</b>	- <b>Viability €€</b>
- ✓ SMS:WS derived hydrolysate is used as carbon source in the fermentation broth





## SUSTAINABLE AND LOW COST BIOPESTICIDES BIOPESTICIDES FROM MUSHROOM COMPOST

- ✓ Biopesticide production:
  - ✓ Optimization tests for fermenting SMS:WS derived hydrolysate:
    - Nitrogen source
    - Oligo-elements: salts (Mg, Fe, Mn, Cu, etc)
    - pH control
    - Aeration
  - ✓ Scale up: Erlenmeyer (50 ml) → bioreactor 2 L → Bioreactor 100L



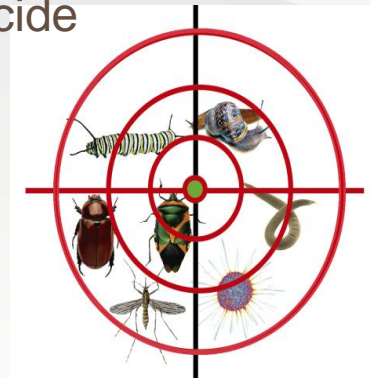
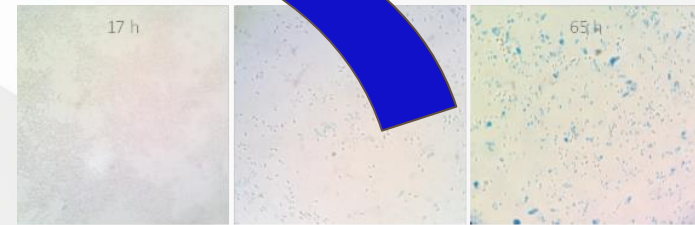


# SUSTAINABLE AND LOW COST BIOPESTICIDES

## BIOPESTICIDES FROM MUSHROOM COMPOST

Process upscale from Erlenmeyer up to Bioreactor 100 L:

- Verify the fermentation process through:
  - Microscopy
  - Dry matter
  - Protein (crystals):
    - concentration
    - size
- Validate biopesticide
  - Bioassays



Special Issue "*Bacillus thuringiensis*  
Toxins"



Pilot-scale\_  
Bioreactor (100L)

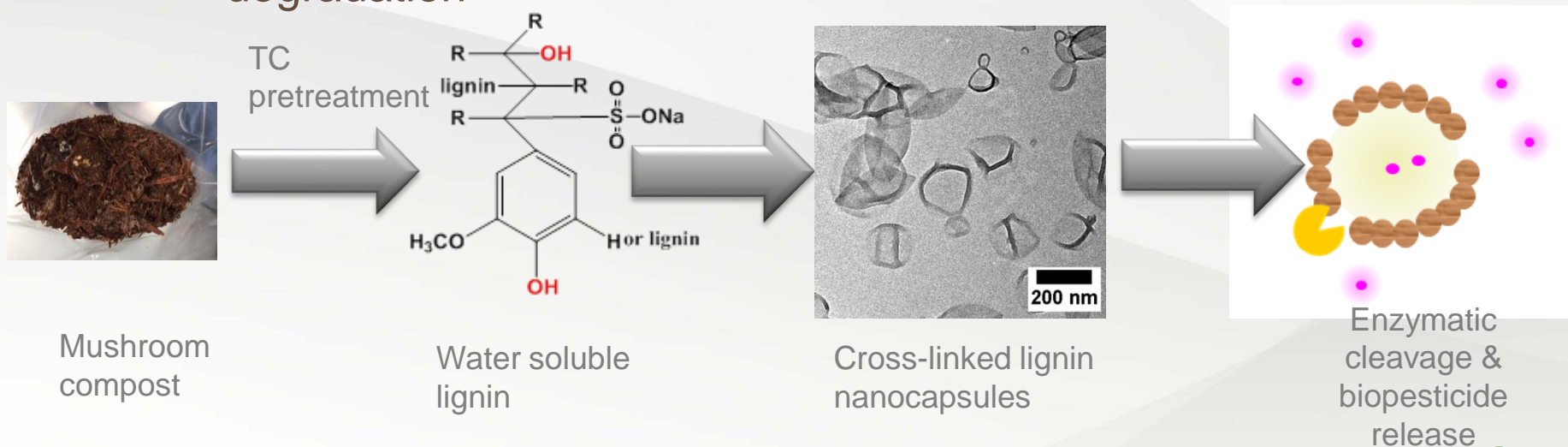


Lab-  
scale\_ErlenMeyer



## SUSTAINABLE AND LOW COST BIOPESTICIDES BIOPESTICIDES FROM MUSHROOM COMPOST

- ✓ Biopesticide and bioencapsulation:
  - ✓ Nanocapsules obtained using biodegradable soluble-lignin through inverse emulsion polymerization
  - ✓ Testing of biopesticide loading and release by enzymatic degradation





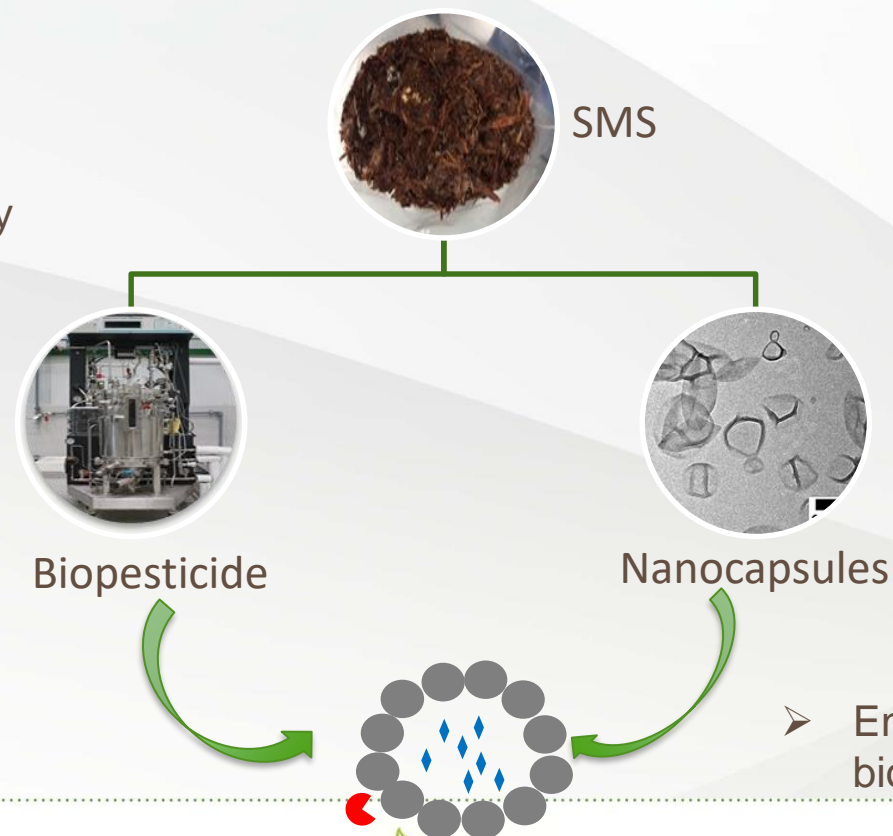
## SUSTAINABLE AND LOW COST BIOPESTICIDES BIOPESTICIDES FROM MUSHROOM COMPOST

✓ SMS valorisation through nanocapsules & biopesticides production

- Validate SMS:WS hydrolysate: biopesticides & toxicity

- Scale up

- Biopesticide encapsulation



- Enzymatic cleavage for biopesticide release



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